**WHAT IS CLAIMED IS:**

1. A method for detecting single photons of high-energy radiation using a detector comprising an array of pixels, each pixel including a charge receptive substrate, said method including the operations of:

capturing high energy photons with the pixel array, the photons generating high-energy ionizing particles within a polycrystalline film deposited on the pixels, and whereby the ionizing particles generate a charge;

collecting the generated charges in each pixel by the charge receptive substrate thereof;

reading out the collected charges using low noise electronics; and

analyzing the read out charges, thereby to detect single photons.

2. A method according to claim 1, wherein the pixels in the array are each less than 1 x 1 mm.

3. A method according to claim 1, wherein the polycrystalline film has a mobility-lifetime product exceeding $10^{-5}$ $cm^2/Vsec$.

4. A method according to claim 1, wherein the detector detects on average at least one electronic charge for each 15 eV or less of incident high energy radiation detected.

5. A method according to claim 1, wherein said analyzing operation includes the operation of comparing the read out collected charges from the reading out operation to a previously determined relationship, the relationship being generated from a calibration based on a statistical analysis of charges/photon over an expected range of photon energies, the relationship being stored in a processor prior to beginning said capturing operation.

6. A method according to claim 5, wherein the relationship is stored as a look-up table.

7. A method according to claim 5, wherein the relationship is stored as a function.

8. A method according to claim 1, further including the operation of imaging the pixels in which single photons have been detected.

9. A method according to claim 1 wherein said analyzing operation further includes the operations of:

comparing the read out collected charges from said reading out operation to a previously determined relationship, the relationship generated from a calibration based on a statistical analysis of charge/photon over an expected range of photon energies, the relationship being stored in a processor prior to beginning said capturing operation;

identifying the pixels interacting with fewer than a predetermined number of photons during a readout based on the comparison of said comparing operation;

recording the number of photons at each identified pixel in a frame; and

after said analyzing operation:

preparing an image based on the pixels identified in said identifying operation.

10. A method according to claim 9, wherein the relationship is stored in a format chosen from the group of: a look-up table, a function and a formula.

11. A method according to claim 1, wherein said analyzing operation includes detecting single photon events in a series of frames taken over a period of time.

12. A method according to claim 11, wherein the series of frames is taken at a rate of from about 1 to about 100 frames per second.

13. A method according to claim 11, wherein the series of frames is taken at a rate of from about 15 to about 30 frames per second.

14. A method according to claim 11, wherein the series of frames is imaged as a series of images.

15. A method according to claim 11, wherein the series of frames is accumulated pixel-by-pixel into a single image, each pixel Pij of the image being equal to the sum of the corresponding Pij pixels in the series of frames.

16. A method according to claim 1 wherein said analyzing operation further includes a discriminating operation that discriminates between photon energies differing by at least 5 keV, said discriminating operation being effected using a readout rate which detects no more than one photon per frame.

17. A method according to claim 1, wherein said analyzing operation further includes the operations of:

switching to charge collection mode when a pixel is located in a high radiation flux environment;

processing the collected charges according to charge collection mode;

returning to the single photon mode when the pixel is located in a low radiation flux environment, thereby to detect single photon events in that pixel; and

repeating said switching through returning operations as often as dictated by the magnitude of the radiation flux.

18. A method according to claim 17, further including the operation of imaging the detected photons.

19. A method according to claim 17, wherein said switching and returning operations are effected by a processor having discriminator software that discriminates in real time whether a pixel is in a low or a high flux environment.

20. A method according to claim 1, wherein the charge receptive substrate is chosen from a group consisting of a thin film transistor (TFT), a complementary metal oxide

semiconductor (CMOS), and a charge coupled device (CCD).

21. A method according to claim 1, wherein the polycrystalline film has a thickness sufficient to absorb 50% of the incident high energy radiation.

22. A method according to claim 1, wherein the polycrystalline film is chosen from a group of materials consisting of mercuric iodide, bismuth iodide, lead iodide, thallium bromide, selenium, lead oxide, mercuric telluride, cadmium-zinc-telluride, and cadmium telluride.

23. A method according to claim 1, wherein the high energy radiation is high flux radiation and wherein said reading out operation reads out the collected charges rapidly so that it generates an effective low flux where single photon events are detectable during said analyzing operation.

24. A method for detecting single photons of high-energy radiation according to claim 1, detection being effected by:

a detector comprising an array of pixels, each pixel having:

a polycrystalline photoconductive film having a mobility-lifetime product exceeding $10^{-5}$ $cm^2/Vsec$;

a conductive contact pad to contact said polycrystalline film;

a conductive contact deposited on top of said film, said contact to provide a bias voltage;

a charge receptive substrate which collects charges generated in said films by the high-energy photons, said substrate having said film deposited thereon;

low-noise electronics in communication with said substrate and reading out the charges collected by said substrate; and

a processor for processing a digital signal produced in and transferred from said electronics, said processor using a previously determined relationship between charges produced per photon to detect single photons, said relationship stored in said processor.

25. A method according to claim 24, wherein the polycrystalline film is chosen from a group of materials consisting of mercuric iodide, bismuth iodide, lead iodide, lead oxide, thallium bromide, selenium, mercuric telluride, cadmium-zinc-telluride, and cadmium telluride.

26. A system for detecting single photons of high energy radiation, said system including:

a detector, said detector including a pixel array, each pixel of said array having a polycrystalline photoconductive film deposited on a charge receptive substrate, said detector operative to capture high-energy photons;

low noise electronics for reading out charges generated by the high energy photons when the photons interact with said film, the generated charges of each of said pixels being collected by said charge receptive substrate of said pixel and read out by said electronics; and

a data processor in communication with said low noise electronics, said processor including a stored previously determined relationship between charge produced per incident photon, said relationship used for comparing the collected charges with said relationship, thereby to detect single photons.

27. A system according to claim 26, wherein said stored relationship is a look-up table generated from a prior calibration of charge produced per incident photon.

28. A system according to claim 26, wherein said stored relationship is a function generated from a prior calibration of charge produced per incident photon.

29. A system according to claim 26, wherein said polycrystalline film has a mobility-lifetime product exceeding $10^{-5}$ $cm^2/Vsec$.

30. A system according to claim 26, wherein said processor is preprogrammed to determine the magnitude of a flux of the radiation, and to switch processing from

charge collection mode to single photon mode and vice-versa when said system or parts thereof are positioned in fluxes of varying magnitudes.

31. A system according to claim 30, wherein the switching is effected by processor software which determines when the flux impinging a pixel is below a predetermined threshold value.

32. A system according to claim 26, wherein said charge receptive substrate includes an electronic circuit fabricated from thin film electronic devices deposited on an inert substance.

33. A system according to claim 26, wherein said polycrystalline film is chosen from a group of materials consisting of mercuric iodide, bismuth iodide, lead iodide, thallium bromide, selenium, lead oxide, mercuric telluride, cadmium-zinc-telluride, and cadmium telluride.

34. A system according to claim 26, wherein said charge receptive substrate is chosen from a group consisting of a thin film transistor (TFT), a complementary metal oxide semiconductor (CMOS), and a charge coupled device (CCD).